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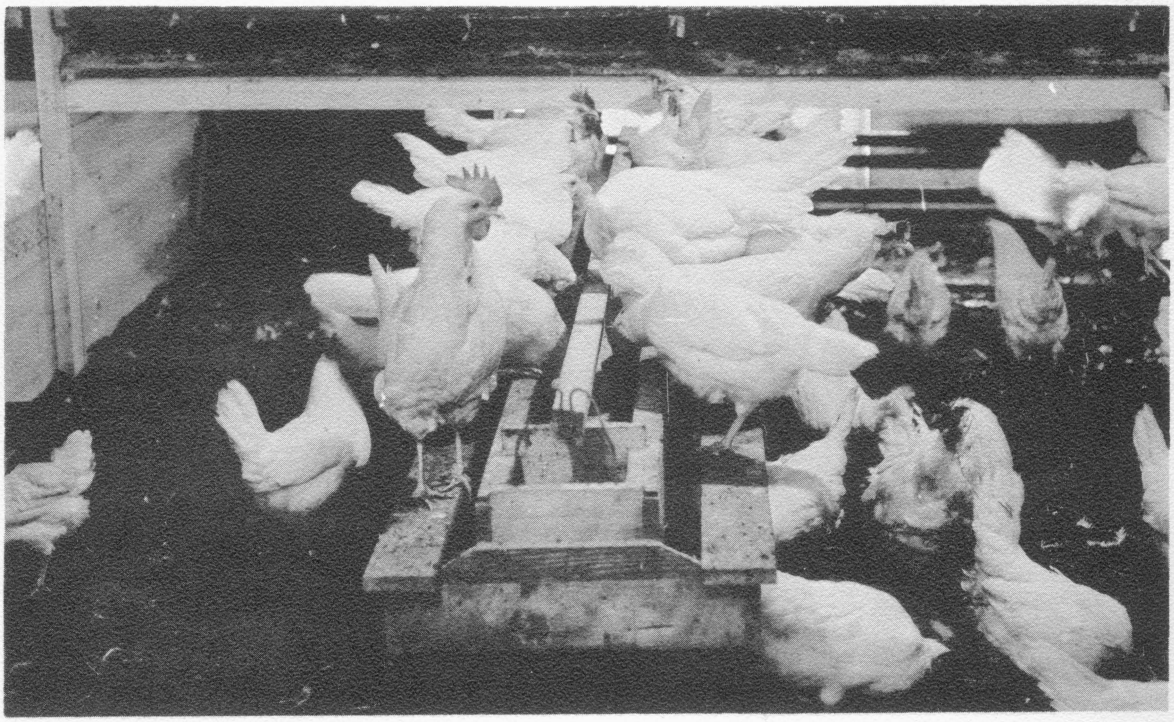

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INSOLUBLE GRIT FOR CHICKENS

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Grit for chickens was among the first dietary considerations in connection with the feeding of domesticated poultry. The chicken has no teeth but it does have an internal organ, the gizzard, for grinding and reducing the feed particles to a suitable consistency for digestion. Since grit was usually present in the gizzard it was taken for granted that grit was essential for chickens of all ages.

When chickens had access to free range which generally provided ample grit there was rarely a need for concern about feeding grit. With the trend to keeping chickens indoors after 1920, the dietary role of insoluble grit became a pertinent question in connection with the transition of chickens from free range to confinement indoors.

It has since been a controversial question. Prior to starting the experiments with insoluble grit by the Ohio Agricultural Experiment Station a questionnaire was sent to a number of leading poultry departments of agricultural colleges and experiment stations to obtain their factual information, beliefs and recommendations relative to the need for insoluble grit for growth of chickens and for layers.

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To briefly cite a few of the replies, one stated hard grit was considered beneficial during early growth of chickens to two pounds, but no need afterwards. Another stated they had conducted numerous experiments with grit for growth of chickens but never published the results because they showed nothing in particular. The majority of replies were expressions of beliefs and arbritrary recommendations not substantiated by factual information. In sum the replies indicated the obvious need for much more factual information than was available at the time.

The immediate prompting of the Ohio Station's work however, was the wartime freight situation in 1943. Most of the commercial grit used in Ohio was shipped from Georgia or North Carolina. This gave rise to two questions: (1) is insoluble grit sufficiently beneficial to justify these shipments especially during wartime? (2) If grit is essential may local sources of high silica (gravel) grit serve the purpose?

The results of the work to be presented involved 16 experiments with the growth of a total of 5050 chickens during the first 8 to 12 weeks, 8 experiments with the growth of a total of 1700 chickens after the first 6 to 8 weeks, and 12 experiments with a total of 1545 layers.

The experiments, tabulated data and discussion of results are presented in three sections:

Section I - Growth of chickens

A. During first 8 to 12 weeks

B. After first 6 to 8 weeks

Section II - Gizzards as affected by insoluble grit, coarse feed and finely ground feed.

Section III - Egg production.

Section I-A

Growth of Chickens During First 8 to 12 Weeks

The question of need for insoluble grit for growth of chickens during the first 8 to 12 weeks is of special importance because it has to do with the growth of broilers as well as the growth of pullets for egg production. Whether the use of insoluble grit yields better growth and feed utilization or merely adds a needless expense is a pertinent matter in broiler production.

If provided, the grit must either be fed in separate feeders, in the floor litter or mixed with the feed. Either procedure is objectionable unless necessary for best results. Moreover the use of insoluble grit adds considerable expense to the feeding of broilers. Combs et al. (1954) estimated that approximately 12,000 to 15,000 tons of insoluble grit are fed annually to broilers in the Delaware area. They estimated the cost of this quantity of grit at slightly over one quarter million dollars each year.

The question of the need or value of insoluble grit for growth of chickens has attracted considerable attention of poultry research workers during the past 50 years. Wheeler (1903) reported that the addition of sand to the ration improved the growth of chicks. A gritless all-mash ration was recommended by Carrick et al. (1927).

Results of two experiments were reported by Bethke and Kennard (1926). In the first experiment with four groups each of 18 day-old White Leghorns in floor pens with wood shavings litter, two groups received coarsely ground feed with and without granite grit (ad. lib.) and two groups received the same feed very finely ground with and without granite grit (ad. lib.). At end of 12 weeks the weight of the four groups was practically the same.

The second experiment was with two groups each of 35 day-old White Leghorns in wire floor pens. The birds received a medium coarse feed with and without granite grit (ad. lib.). At the end of 10 weeks the average weight of the birds that received grit was 0.27 pounds more than that of the birds without grit.

The foregoing results from single experiments with a small number of birds under a given set of conditions are inconclusive and could be misleading. The averaged results of repeated experiments under practical conditions with a large total number of birds obtained later (1943 to 1949) by the Ohio Station are far more conclusive.

Platt (1935) conducted an experiment with three groups each of 50 chicks in batteries. One group received no grit; a second group received 3.3 percent mica grit mixed in feed; a third group received the feed with 6.5 percent mica grit. At the end of 10 weeks the average weights per bird of the three groups was 2.21, 2.12 and 2.39 pounds respectively. The feed economy was not influenced by the use of mica grit.

Gizzard complications as affected by insoluble grit were studied by Bird et al. (1937). They reported an abnormal thickening or swelling of the gizzard living distinct from crater lesions, among chickens fed a finely ground gritless ration, which may be prevented by feeding grit or a coarsely ground ration. Evidence indicated that poor growth may be associated with this abnormality. Hence growth might be improved under such conditions by supplying grit. They cautioned however, that this advantage may be offset by the bad effect of grit on chicks having crater lesions.

In an experiment with two groups each of 75 chicks in bacteries Tepper et al. (1939) obtained no advantage in growth or feed efficiency from the addition of one percent granite grit to an all-mash ration.

Two experiments on influence of various insoluble grits on battery raised broilers during the first eight weeks were conducted by Cooney (1941). In the first experiment

were two groups each of 28 chicks with and without insoluble grit and the second experiment was a repetition with two groups each of 35 chicks. The average weight of broilers of both experiments at marketing time (8 weeks) failed to show that granite or silica grit played more than a minor role where fed as a supplement to a balanced ration. Likewise there was little or no evidence of increased feed utilization from the use of grit.

Heuser and Norris (1946a) found little or no benefit from feeding granite grit to chicks in batteries during the first eight weeks.

An experiment on the use of grit and its effect on growth and upon ascarid infections was conducted by Riedel (1950). He found the use of granite grit in the diet failed to increase the weight of broilers raised in batteries under controlled laboratory conditions. No evidence was obtained to indicate that the abrasive action of grit in the growing chicken affected ascarid galli within the host.

Unlike most grit experiments Combs et al. (1954) conducted two experiments with a large number (2400 "marked birds" among larger flocks of broilers) of birds under practical conditions. At the end of both experiments (9 and 10 weeks) the weight of birds and feed efficiency of the broilers that received an all-mash ration with free access

to granite grit was practically the same as that of the birds without grit. Two other groups of broilers received a cracked corn-mash mixture finishing ration after the first seven weeks (on all-mash) for a period of two weeks with and without granite grit. At the end of 9 (Exp. 1) and 10 (Exp. 2) weeks the averaged weight of the broilers with free access to granite grit was slightly more (0.06 lb. per bird) with a slightly less feed requirement (0.05 lb. less per lb. live weight). However the best returns over cost of feed were obtained from the all-mash ration without grit.

Scott and Heuser (1957) conducted an experiment with four groups each of 20 chicks in wire floor pens. Two groups received an all-mash ration with and without insoluble grit and two groups received a grain and mash ration with and without grit. Contrary to a previous experiment (Heuser and Norris 1946a) the results of this experiment indicated an improvement in growth and feed utilization from the use of either granite or feldspar grit. Both grits were consumed equally well when fed separately, but the feldspar grit was preferred when the birds had opportunity to choose between them.

In view of the liability of misleading results that may be obtained from unrepeated experiments with a small number of birds, the results from the grit experiments by

the Ohio Station were obtained from repeated experiments during a prolonged time period (6 years) with a large total number of birds kept under practical management conditions.

EXPERIMENTAL

The experiments were started with groups of 150 to 200 day-old chicks in continuous brooder house pens (10 by 20 ft.) with concrete floors covered with wood shavings.

Weight of birds, feed consumption and mortality were recorded. Since there was no difference in the rate of mortality to be attributed to the use or non-use of insoluble grit, these records were not included in the tabulated data to be presented.

The grit rations included 5 percent chick size granite grit mixed with the all-mash feed. It had been observed that individual birds, even different flocks, especially young chickens, differ greatly in their intake of insoluble grit. To avoid such irregularities and to insure a known grit intake of all birds in the flock the granite grit was fed as a part of the feed mixture. The granite grit was considered as extraneous material and was not included in the feed consumption data.

During the first 8 to 12 weeks the starter ration was either a coarsely ground all-mash or the same mash finely ground as indicated. The coarsely ground all-mash included

coarsely ground corn (with particles up to the size of wheat kernels) expeller process soybean oil meal and wheat bran all of which were mainly responsible for its coarseness. In other words 60 percent of the ration was composed of rather coarse material. The ingredients of the ration are given in Table 1.

RESULTS AND DISCUSSION

Summarized results of eleven experiments in which the birds received coarse feed with and without granite grit are tabulated in Table 2. In the six experiments with White Leghorns there was practically no difference in growth and feed utilization between the birds that received granite grit and those that did not. Less consistent results were obtained in the five experiments with Rhode Island Reds. In three of the experiments the grit birds made the best growth. However there was practically no difference in the averaged results of the five experiments. Had the work perchance been confined to experiments 7 and 9 the results would have seemed quite in favor of the birds that received no grit. It required the three additional experiments (8, 10 and 11) to give the better answer to the question.

Better feed utilization was obtained from the birds without grit in eight of the eleven experiments with an overall average of 0.08 pounds less feed per pound live weight.

In five experiments the birds received the feed finely ground with and without granite grit. The results of these experiments (Table 3) show little or no difference in growth and feed utilization between the birds that received granite grit and those that did not.

SUMMARY

Results of 11 experiments with the growth of a total of 3550 chickens that received a coarse all-mash ration with and without granite grit, and 5 experiments with the growth of a total of 1500 chickens which received the same ration finely ground with and without granite grit, have been presented and discussed.

In the 11 experiments with coarsely ground feed the averaged results showed no difference in the rate of growth from the use of granite grit. Slightly better feed utilization was obtained from the birds without grit.

When the feed was finely ground practically the same results were obtained in growth and feed utilization with or without granite grit.

SECTION I-B

The role of insoluble grit in the diet for growth of chickens after the first six to eight weeks has received comparatively little attention by research workers. For one thing until recently the chickens were usually transferred

after the brooding period to outdoor range where ample grit was available. Recently there has been an ever increasing trend to raising chickens to maturity indoors, especially pullets for egg production. Consequently the need for insoluble grit for growth of chickens indoors after the first six to eight weeks became a pertinent question.

Two experiments were conducted by Bethke and Kennard (1926b). The first experiment was with two groups each of 13 White Leghorn pullets in floor pens littered with wood shavings. The birds were 12 weeks old at beginning of experiment and at the end were 23 weeks old and ready to lay.

The ration was composed of whole wheat, cracked corn, coarsely ground corn and other mash ingredients. The group which received the ration without granite grit weighed slightly more (.087 lb. per bird) than those which had free access to granite grit.

The second experiment included two parts. The first part was conducted with the growth of two groups each of 25 White Leghorn pullets and cockerels in wire floor pens from 8 to 16 weeks. The ration in both parts of the experiment was composed of whole wheat, coarsely ground corn and other mash ingredients. At end of first part of the experiment the birds with free access to granite grit had gained 0.08 lb. more per bird than those without grit.

The second part of the experiment was a continuation of the experiment with 9 pullets in one group and 10 pullets in the other from 18 to 28 weeks. During this period the pullets without grit gained 0.25 pounds per bird more than those with free access to granite grit. The group of pullets without grit started to lay one week before those that received granite grit. Needless to say the results of both experiments with such a small number of birds are of doubtful significance.

Buckner et al. (1926) reported growth results obtained from an experiment conducted with two groups each of 10 White Leghorns in floor pens. The ration was composed of cracked corn, whole wheat and mash. The gain in weight per bird of the group that received the free choice of gravel grit from 12 to 30 weeks was 0.17 pounds greater than that of the birds without grit.

EXPERIMENTAL

The experiments with growth of chickens as affected by the feed with (5%) and without granite grit after the first six to eight weeks were started with day-old chicks and continued in the same brooder pens during the later period of growth. The only difference in procedure from the first 6 to 8 weeks (Part I-A) was the use of medium sized granite grit and the ration was reduced to 16.5 percent protein and included

whole corn and oats (Table 1). The data to be presented was obtained from eight experiments with the growth a total of 1700 White Leghorn and Rhode Island Red cockerels and pullets after the first 6 to 8 weeks.

RESULTS AND DISCUSSION

The growth and feed utilization results of one experiment from 8 to 18 weeks in biweekly periods with 750 White Leghorns are recorded in Table 4. This experiment included three parts: (1) cockerels and (2) pullets which received coarse feed with and without granite grit and (3) pullets that received finely ground feed with and without grit.

It will be noted that at the age of eight weeks at beginning of the experiment the weight of the birds was practically the same in the six groups each of which had previously received the starting ration with or without grit during the first eight weeks. The cockerels continued to show no difference in rate of growth during the eight weeks to follow when their ration included 45 percent whole corn and oats, with or without grit. Feed utilization varied during different biweekly periods. At the end of the experiment there was a slight difference in favor of the birds that received coarse feed with grit.

Despite the biweekly fluctuations in weight of birds and feed utilization between the groups that received coarse feed with and without granite grit these differences were not

reflected in the averaged results of the biweekly periods. This suggests that the periodical fluctuations of the results between the grit and no grit birds were coincidental and that the averaged results of the six biweekly periods are more significant than those obtained at the end of the different biweekly periods.

Unlike the birds that received the coarse feed, the feed utilization of the pullets that received finely ground feed with grit was consistently better in each of the six biweekly periods. However, these results were not substantiated by the averaged results of repeated experiments (Table 5)

Summarized results of five experiments with the growth of chickens that received coarse feed with and without granite grit after the starting period and three experiments in which the chickens received finely ground feed with and without grit are recorded in Table 5.

The gains in weight of birds that received coarse feed with and without granite grit varied in different experiments but there was little difference in the averaged results of repeated experiments.

Had this work been limited to experiment 4 it would have appeared that the use of grit increased the rate of growth. The averaged results of five experiments however, indicated that the use of grit had little or no effect upon growth. Obviously the increased weight gains recorded in

experiment 4 for the birds that received grit was due to other causes. The same can be said of the differences in gains in weight in experiments 2 and 3 in which the birds received finely ground feed with and without grit. It is the averaged results of repeated experiments with a larger total number of birds that provides the better answer to the question.

Likewise feed requirements per pound gain varied in different experiments but the averaged results of repeated experiments both with coarse and finely ground feed showed that the use of granite grit had little or no effect upon feed utilization.

SUMMARY

Results of repeated experiments with the growth of a total of 1700 chickens after the first 6 to 8 weeks as affected by coarse feed (which included 45 percent whole corn and oats) and finely ground feed with (5 percent in feed) and without granite grit have been reported and discussed.

The averaged results of five experiments with a total of 1000 chickens which received coarse feed with and without grit, and 3 experiments with a total of 700 chickens that received finely ground feed with and without grit indicated that the use of granite grit had little or no effect upon growth and feed utilization.

SECTION II

Gizzards as Affected by Insoluble Grit, Coarse Feed and Finely Ground Feed

Since the gizzard is the organ primarily responsible for reducing feed particles to suitable size for effective digestion, it would be expected that this organ could be much affected by insoluble grit, coarse feed, and finely ground feed. This contention has prompted considerable research work with reference to the gizzard.

Buckner et al. (1926) reported that the feeding of granite grit to White Leghorns to age of 30 weeks caused increased weight of gizzards.

The use of insoluble grit to the extent of 6.5 percent of the ration was found, by Platt and Stephenson (1935) to increase all gizzard measurements, especially the width and thickness.

Grit and grit-like substances were found, by Almquest (1937), to exert a diminishing effect on severity of gizzard erosion. Fineness or coarseness of the diet had no effect on the condition of the gizzard lining.

An abnormal thickening or swelling of the gizzard lining distinct from crater lesions was reported, by Bird et al. (1937), to occur in young chicks fed a finely ground grit-less ration. They stated the condition may be prevented by feeding grit or a coarsely ground ration. It was pointed out, however, that grit had a bad effect on chicks having crater lesions.

The work of the Ohio Station to be reported in this paper was concerned with the weights of gizzards and their linings and gizzard contents as affected by insoluble grit, coarse feed and finely ground feed.

EXPERIMENTAL

The different groups of White Leghorns from which the gizzards were taken, were started as day-old chicks in battery brooders and continued in batteries with their respective rations and procedures until completion of the experiments.

Gizzards were taken from representative pullets of each group at age of 20 weeks when ready to lay. The remaining pullets of each group were transferred to individual laying batteries where they were continued as layers. After the egg production periods (38 weeks Exp. 1, 54 weeks Exp. 2) gizzards were taken from representative birds of each group. The birds from which gizzards were taken were fasted 24 hours before killing and removal of gizzards.

After the first eight weeks to the end of 20 weeks the pullets received the whole corn and oats-mash mixture, Table 1. As layers they were fed the whole grain-mash ration No. 1 for layers, Table 9.

Granite grit (medium sized) was fed as a part (5 percent) of the feed mixture. Likewise the calcium supplement for layers was mixed (5 percent) with the feed.

The weights of gizzards include the linings without contents and without adhering external fat.

The external fatty tissue weights were made from gizzards taken from pullets at the age of 20 weeks.

RESULTS AND DISCUSSION

Studies were made of 288 gizzards taken from White Leghorn pullets before and after egg production.

On basis of averaged results of two experiments, Table 6, the smallest gizzards were from the birds that received finely ground feed without granite grit. The addition of five percent granite grit to the finely ground feed increased the weight of gizzards from pullets 19 and layers 10 percent. The gizzards from pullets and layers that received coarse feed without grit were 19 and 26 percent respectively greater in weight than those from the birds that received finely ground feed without grit. The addition of grit to coarse feed increased the weight of gizzards from pullets 11 percent but did not increase the weight of gizzards from layers. The heaviest gizzards were from pullets that received coarse feed and grit. The overall average weight of gizzards from pullets was 4.5 percent greater than that of the gizzards from layers.

Gizzard linings being in direct contact with feed and grit were more affected by size of feed particles and grit

than was the size of the gizzards. The gizzard linings from the birds that received finely ground feed without grit were the lightest in weight of all groups. The addition of five percent granite grit to the finely ground feed increased the weight of linings from pullets 19 percent and from layers 20 percent. This was comparable to the increased weight of the gizzard linings from the birds that received coarse feed with and without granite grit.

It will be noted that in every instance the weight of the gizzard linings after (38 weeks Exp. 1, 54 weeks Exp. 2) egg production was less (an overall average of 33 percent less) than that of the gizzard linings from pullets before egg production. Might this be a wearing down of the gizzard lining from increasing age and servicing the larger amount of feed in connection with egg production? May the linings be renewed or reconditioned during the molting period? These questions might be answered by obtaining similar gizzard data from layers just before and after the molt.

A study of gizzard contents as affected by coarse and finely ground feed with and without granite grit was made with 186 gizzards, Table 7. The average weight of contents of gizzards from pullets and layers after fasting for 24 hours that had received coarse or finely ground feed with grit was 2.45 times that of the gizzard contents of the birds that received the same feed without grit. The grit content

largely accounted for the difference in weight. It will be noted that the gizzard from the birds not supposed to have received grit, did nevertheless contain a small amount of illicit grit despite the fact they had always been in batteries. It is interesting to note also that the birds which received coarse feed without grit had a greater urge to obtain illicit grit than those given finely ground feed without grit. This was evidenced by the fact that during the first 20 weeks as pullets they obtained 6.5 times more, and during 38 weeks as layers they obtained 8.6 times more illicit grit than did the birds that received finely ground feed without grit. The source of this grit or how obtained is unknown.

The weights of contents of gizzards from pullets before egg production in every instance regardless of coarse or finely ground feed with or without grit were 36 percent (overall average) greater than the gizzards from layers after 38 weeks egg production. Contrariwise the ash and grit content of gizzards from layers was greater than from pullets in all instances. No explanation is offered for the differences in weights of gizzard contents before and after egg production. All the birds were fasted 24 hours before killing and removal of the gizzards.

Gizzards naturally have more or less external fatty tissue adhering to them. It was observed however, that the

gizzards from birds that received finely ground feed without grit appeared to have more external fat adhering to them than the gizzards from some of the other groups. This prompted the study of 53 gizzards with reference to the amount of external fatty tissue adhering to gizzards as affected by coarse and finely ground feed with and without grit.

It will be observed in Table 8, that the smallest gizzards were from the birds that received finely ground feed without granite grit and that they were surrounded by the greatest amount of adhering fatty tissue-about twice that of any of the other groups. The gizzards with the least amount of external fat were those from the pullets that received coarse feed without grit. There was also a low fat storage around the gizzards from the pullets raised on range. No positive explanation of the differences in external fat deposits is available. A similar study of external gizzard fat of gizzards taken from layers just before and after molting might be of still greater interest.

SUMMARY

Studies were made of a total of 288 gizzards from pullets before and after egg production as affected by coarse and finely ground feed with and without granite grit.

Feed texture and/or granite grit definitely affected the weight of gizzards. The smallest gizzards were from the

birds that received finely ground feed without grit. The weight of gizzards (average of pullets and layers) was increased 15 percent when the birds received finely ground feed with granite grit. Coarse feed with or without grit had a similar effect.

The heaviest gizzards were from pullets that received coarse feed and granite grit.

Gizzard linings were also affected by feed texture and/or granite grit. The lightest in weight were the linings of gizzards from birds that received finely ground feed without grit. The addition of grit to finely ground feed increased the weight of gizzard linings as did the use of coarse feed with or without grit.

Studies of 53 gizzards from pullets revealed that the amount of external fatty tissue adhering to gizzards was correlated with feed texture and use of granite grit. The smallest gizzards from birds that received finely ground feed without grit were surrounded by about twice the amount of fatty tissue as the larger gizzards from birds that received coarse feed or grit.

SECTION III

Egg Production

The need for insoluble grit by layers has been less questionable than that for the growth of chickens. Nevertheless it has been the subject of considerable research work.

In an experiment with 24 layers in batteries, Tepper et al. (1939) obtained 5 more eggs per bird during 31 weeks with 0.30 pounds less feed per dozen eggs from layers fed a whole grain and mash ration which contained 1 percent granite grit than from the layers that received no grit.

Heuser and Norris (1946b) conducted an experiment during 46 weeks with two groups each of 30 White Leghorns. The groups which received a whole grain and mash ration with the free choice of granite grit and oyster shell laid 15 more eggs per bird with 8 percent less feed than the layers without grit.

An experiment was conducted by Balloun et al (1956) with four groups of 24 caged layers. Two groups received an all-mash ration with and without grit and two groups received a whole grain and mash ration with and without grit. Better egg production and feed utilization was obtained from both rations when supplemented by the free choice of granite grit. All-mash with grit yielded 3 percent more eggs with 9 percent less feed. The grain and mash ration with grit yielded 6 percent more eggs with 4.5 percent less feed.

In an experiment with three groups of 40 layers in floor pens during 12 weeks Scott and Heuser (1957) obtained improved egg production and feed utilization when a whole grain and mash ration was supplemented by the free choice of either granite or feldspar grit.

The results to follow in egg production and feed utilization as affected by rations with and without insoluble grit were obtained by the Ohio Agricultural Experiment Station in 12 experiments during a period of 5 years with a total of 1545 layers.

EXPERIMENTAL

The experiments with egg production were conducted with groups of 45 to 50 trapnested layers confined indoors in floor pens littered with wood shavings. Egg production, feed consumption, intake of calcium supplement and insoluble grit, monthly weight of birds, and mortality were recorded. Since the weight of birds and mortality were not affected by insoluble grit these data were not included in the tabulated data to follow.

The pullet layers were raised on range and had access to insoluble grit previous to housing and the beginning of the experiments. During the experiments the calcium supplement and insoluble grit (when fed) were kept before the birds at all times (free choice) in separate feeder compartments.

Egg production is expressed as eggs per bird on basis of hen days. Feed consumption as pounds feed per dozen eggs and calcium supplements and insoluble grit as percent of total feed intake.

Two rations, No. 1 and No. 2 were used in the experiments. For their composition see Table 9.

RESULTS AND DISCUSSION

Results of an experiment with 4 groups each of 50 Rhode Island Red pullets which received 2 different kinds of insoluble grit during 46 weeks are given in Table 10. Improved egg production and feed utilization were obtained from the two groups that received insoluble grit, when supplemented by oyster shell.

Of greatest interest in this experiment was the amazing amount of granite grit consumed by the layers having free access to granite grit without oyster shell. Their desperate urge to obtain calcium was mistakenly focused upon granite grit. In their depraved urge to obtain calcium they consumed granite grit at the rate of nearly 26 percent of total feed intake. In other words the 50 layers consumed a total of 1200 pounds of granite grit or 24 pounds per bird within 46 weeks. No less surprising, this remarkable accomplishment did not noticeable ill affect the birds except for their inability to produce strong shelled eggs without a calcium supplement.

All eggs were thin shelled, "soft shelled" or without shells. Whether egg production was normal, except for the shells could not be determined. Many of the eggs could not be recorded even though the birds were trapnested. A considerable number of eggs were lost from "egg eating".

In view of the results of this experiment poultrymen need have no fear of layers consuming too much granite grit under normal conditions, when they also have free access to a calcium supplement.

In further reference to increased intake of insoluble grit when layers are deprived of a calcium supplement, it is interesting to note the averaged results obtained by Kennard (1944) from two yearly experiments. Each experiment included 2 groups of 40 White Leghorns, 1 of which received the free choice of mica grit and oyster shell while the other group received mica grit without oyster shell. Egg production averaged 148 and 101 eggs per bird with a mica grit intake of 1.42 and 6.98 percent respectively. Thus, the birds without oyster shell consumed five times more mica grit in their quest for calcium to form egg shells.

Since the mica grit, unlike granite grit was shatterless and the excess less easily passed from the digestive tract the 7 percent intake of mica grit might be considered as remarkable as the 26 percent intake of granite grit cited under similar circumstances.

In two experiments Table 11, the granite grit intake was also greatly increased when layers received feed containing 5 percent pulverized calcite. They consumed 9.6 times more granite grit than comparable groups which received

the same feed with the free choice intake of the same amount (averaged results) of calcite grit. No definite explanation is offered for this aberration. The excessive intake of granite grit may have been prompted by an urge to overcome some abnormal digestive condition due to the pulverized calcite in the feed. Possibly there was an excess of freely available calcium to be dealt with and the birds sought relief by eating grit and other extraneous material. In experiment 1 egg production and feed utilization was much the same. In experiment 2 both egg production and feed utilization were in favor of the free choice feeding of calcite grit.

The results cited in Table 10 indicated improved egg production and feed utilization when oyster shell was supplemented by insoluble grit. The logical question to follow is whether or not limestone grit may serve the dual purpose of a calcium supplement and also serve as a substitute for insoluble grit. This question is dealt with by the results of three experiments in Table 12.

The averaged results of the three experiments with coarse feed and the free choice of calcite grit with and without granite grit clearly indicate the need of insoluble grit to supplement calcite grit both for better egg production and feed utilization.

Contrariwise the two experiments with finely ground feed showed little or no advantage from the use of granite grit. It is noteworthy that the granite grit intake by the birds in experiments 1 and 2 with coarse feed averaged nearly twice that of the comparable birds which received finely ground feed in experiments 4 and 5.

Summarized results of four experiments in which layers received coarse feed and free choice of oyster shell with and without granite or silica grit are given in Table 13.

Better egg production and feed utilization were obtained from the layers that received insoluble grit, with one exception. In experiment 2 the results were slightly negative for the group that received granite grit. However in the four experiments the birds that received granite grit averaged seven more eggs per bird with 0.39 pounds less feed per dozen eggs than did the birds without grit. A fifth experiment was conducted with two groups each of 45 layers, one of which received the ration and oyster shell with and the other without granite grit. Egg production per bird was 199 and 174 and feed per dozen eggs was 4.86 and 5.37 pounds respectively. Averaged results of the five experiments with and without granite grit was 160 and 150 eggs per bird and feed per dozen eggs was 6.72 and 7.16 pounds respectively. The results of the fifth experiment with granite grit were not included in Table 13 because there was no corresponding group of layers that received silica grit.

It is remarkable that in every instance the best egg production and feed utilization were obtained from the birds that received crushed silica (gravel) grit. It is noteworthy that the intake of the more permanent (shatterless) silica grit was but one fourth that of the granite grit.

SUMMARY

Results in egg production and feed utilization as affected by rations with and without insoluble grit, obtained from 12 experiments with a total of 1545 layers have been presented and discussed.

Improved egg production and feed utilization were obtained when coarse feed and free choice of either oyster shell or calcite grit was supplemented by the free choice of an insoluble grit.

Better results in egg production and feed utilization (coarse feed) were obtained from crushed silica (gravel) grit than from granite grit.

The averaged results of two experiments with finely ground feed with and without granite grit showed little difference in egg production and feed utilization.

GENERAL SUMMARY

Results in growth of chickens gizzard development, egg production and feed utilization as affected by coarse and finely ground feed with and without insoluble grit have

been presented and discussed in three sections:

1-A Growth of chickens during the first 8 to 12 weeks.

1-B Growth of chickens after the first 6 to 8 weeks.

2 Gizzards as affected by texture of feed and granite grit.

3 Egg production.

Results from 11 experiments with the growth of a total of 3550 chickens that received coarse and finely ground feed with and without granite grit during the first 6 to 12 weeks showed little or no difference in growth or feed utilization from the use of granite grit.

Likewise little or no difference in growth or feed utilization resulted from the use of granite grit in 5 experiments with the growth of a total of 1500 chickens that received finely ground feed with and without granite grit during the first 8-12 weeks.

In five experiments with the growth of a total of 1000 chickens which received coarse feed with and without grit after the first 6 to 8 weeks and three experiments with a total of 700 chickens that received finely ground feed with and without grit little or no benefit in growth or feed utilization resulted from the use of granite grit.

Studies were made with a total of 288 gizzards and contents from pullets before and after egg production. The

studies were with reference to weights of gizzards, gizzard linings, contents and fatty tissue adhering to gizzards as affected by texture of feed and/or granite grit.

The smallest gizzards were from the birds that received finely ground feed without grit. Moreover these gizzards had the lightest linings. Contrariwise the smallest gizzards were surrounded by more (twice as much) fatty tissue than the larger gizzards from birds that received coarse feed with or without grit or finely ground feed with granite grit.

Egg production and feed utilization by layers, unlike the results in growth of chickens were improved when coarse feed and oyster shell or calcite grit was supplemented by the free choice of either granite grit or silica grit.

Better results in egg production and feed utilization were obtained from crushed silica (gravel) grit than from granite grit.

In two experiments the averaged results showed little difference in egg production and feed utilization when the layers received finely ground feed with or without granite grit.

Table 1

Coarse feed[a] for growth of chickens

Ingredients	Starter first 8 to 12 weeks	After first 6 to 8 weeks
Whole corn	-	25
Whole oats	-	20
Ground corn-coarse	40	15
Wheat middlings	20	10
Wheat bran	10	5
Meat scraps[b]	5	4
Dried skim milk	5	3
Soybean oil meal	12	10
Alfalfa meal[c]	5	5
Salt-manganese mix[d]	1	1
Oyster shell chick size	2	2
Feeding oil[e]	0.1	0.1
Percent protein	18.5	16.5

a - Finely ground feed prepared by grinding coarse feed

b - Meat and bone meal - 50% protein

c - Dehydrated 17% protein

d - Composed of iodized salt 9, Tech. Manganese sulfate 1

e - 1500 A 400 D

Table 2

Growth of chickens and feed efficiency as affected by coarse feed with and without granite grit during the first 8 to 12 weeks

Exp. No.	No. birds	Kind of birds	Duration of Exp.	Weight per bird		Feed per pound live weight	
				With 5 per-cent grit	Without grit	With 5 per-cent grit	Without grit
			(weeks)	(lb.)	(lb)	(lb.)	(lb.)
1	350	Leghorn[a]	8	1.10	1.11	3.62	3.62
2	350	"	8	1.05	1.10	3.29	3.15
3	350	"	8	1.07	1.11	3.29	3.05
4	300	"	10	1.39	1.41	3.36	3.15
5	300	"	10	1.38	1.46	4.30	3.99
6	400	"	10	1.67	1.72	3.70	3.65
7	300	R.I.Reds[b]	10	1.69	1.81	3.43	3.51
8	300	"	12	2.35	2.13	3.72	3.53
9	300	"	12	2.22	2.53	4.31	4.14
10	300	"	12	2.35	2.19	3.71	3.79
11	300	"	12	2.31	2.18	4.30	4.27
Total	3550	Av.		1.69	1.70	3.73	3.61

a - S.C. White Leghorn pullets in Exps. 1 to 5
S. C.White Leghorn cockerels in Exp. 6

b - Rhode Island Red pullets in Exps. 7 to 11

Table 3

Growth of chickens and feed efficiency as affected by finely ground feed with and without granite grit during the first 10 to 12 weeks

Exp. No.	No. Birds	Kind of birds	Duration of Exp.	Weight per bird		Feed per pound live weight	
				With 5 percent grit	Without grit	With 5 percent grit	Without grit
			(wks)	(lb.)	(lb.)	(lb.)	(lb.)
1	300	Leghorn[a]	10	1.47	1.46	3.26	3.20
2	300	"	10	1.46	1.47	3.68	3.82
3	300	"	10	1.81	1.72	3.33	3.38
4	300	R.I.Reds[b]	12	2.37	2.40	3.73	3.87
5	300	R.I.Reds[c]	12	2.06	2.04	3.62	3.59
Total	1500		Av.	1.83	1.82	3.52	3.57

a - S.C. White Leghorn pullets

b - Rhode Island Red cockerels

c - Rhode Island Red pullets

Table 4

Growth and feed utilization of white leghorns after the first eight weeks as affected by coarse and finely ground feed with and without granite grit

Weeks At end of:	Cockerels[a] with coarse feed				Pullets[a] with coarse feed				Pullets[a] with finely ground feed			
	Weight per bird		Feed per lb. live weight		Weight per bird		Feed per lb. live weight		Weight per bird		Feed per lb. live weight	
	Grit	No Grit	Grit[b]	No Grit	Grit[b]	No Grit	Grit[b]	No Grit	Grit[b]	No Grit	Grit[b]	No Grit
	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)
8	1.23	1.19	3.14	3.38	0.98	1.02	3.92	3.55	1.03	1.04	3.47	3.57
10	1.67	1.72	3.70	3.65	1.38	1.46	4.30	3.92	1.46	1.47	3.69	3.82
12	2.15	2.18	4.05	4.01	1.86	1.84	4.21	4.53	1.87	1.86	4.01	4.35
14	2.61	2.62	4.58	4.35	2.28	2.22	4.56	4.67	2.28	2.27	4.45	4.83
16	3.09	3.09	5.12	5.08	2.58	2.50	5.25	5.32	2.44	2.49	5.28	5.39
18	3.29	3.26	5.96	6.02	2.75	2.65	5.99	6.16	2.80	2.75	5.76	5.97
Av.	2.34	2.34	4.42	4.42	1.97	1.95	4.71	4.69	1.98	1.98	4.44	4.66

a - With a total of 250. Overall total in experiment 750 birds

b - Five percent medium sized granite grit in feed

Table 5

Growth of chickens and feed utilization as affected by coarse and finely ground feed with and without granite grit after the first six to eight weeks

Exp. No.	No. birds	Age at start and end of Exp.	Duration of Exp.	Gain per bird		Feed per lb. gain	
				Grit[f]	No Grit	Grit[f]	No Grit
		(wks)	(wks)	(lb)	(lb)	(lb)	(lb)
	Coarse Feed						
1	250[a]	8-18	10	1.77	1.63	7.29	8.25
2	250[b]	8-18	10	2.06	2.07	8.58	7.74
3	200[c]	6-19	13	2.97	2.94	5.90	6.55
4	250[d]	8-20	12	3.75	3.45	5.63	5.41
5	250[d]	8-16	8	2.22	2.39	6.00	5.42
Total	1000		Average	2.55	2.50	6.67	6.66
	Finely ground feed[e]						
6	250[a]	8-18	10	1.77	1.70	7.45	7.49
7	250[c]	6-19	13	3.22	3.01	6.19	5.83
8	200[d]	8-20	12	3.23	3.50	5.57	6.10
Total	700		Average	2.74	2.74	6.40	6.47

a - White Leghorn pullets
b - White Leghorn cockerels
c - Rhode Island Red-Cockerels and pullets on basis of equal no. each
d - Rhode Island Red-Cockerels
e - Same ingredients as coarse feed
f - Five percent medium sized granite grit in feed

Table 6

Weight of chicken gizzards and gizzard linings as affected by coarse vs. finely ground feed with and without granite grit. Experiments conducted with S.C. White Leghorns started as day-old pullets in batteries and continued in batteries to end of experiment

Kind of feed with or without granite grit	Exp. No.	Number gizzards		Weight each gizzard		Weight each gizzard lining	
		Pullets[a]	Layers[b]	Pullets[a]	Layers[b]	Pullets[a]	Layers[b]
				(gms)	(gms)	(gms)	(gms)
Finely ground No. grit	1	32	18	26.56	27.67	2.72	1.55
	2	10	15	30.10	27.80	1.80	1.45
			Average	28.33	27.74	2.26	1.50
Finely ground with 5% grit	1	13	23	29.00	32.13	3.38	1.83
	2	11	15	38.40	28.80	2.00	1.77
			Average	33.70	30.47	2.69	1.80
Coarsely ground No grit	1	38	18	31.82	34.11	3.11	1.75
	2	10	15	35.50	35.93	2.00	1.73
			Average	33.66	35.02	2.56	1.74
Coarsely ground with 5% grit	1	21	23	34.33	32.22	3.62	1.85
	2	11	15	40.40	36.00	2.33	2.13
			Average	37.37	34.11	2.98	1.99
		Overall average		33.27	31.84	2.62	1.76

a - At end of 20 weeks

b - After 20 weeks the pullets continued as layers in individual cages for 38 weeks in Exp. 1 and 54 weeks in Exp. 2.

Table 7

Gizzard contents as affected by coarse vs. finely ground feed with and without granite grit

Kind of feed with and without granite grit	Exp. No.	no. gizzards	Gizzard content-total			Granite grit-content	
			Av. weight each	Av. weight ash	Percent ash	Av. weight in each gizzard	Percent of ash
			(gm)	(gm)	(pct)	(gm)	(Pct.)
Finely ground No grit	1[a]	32	6.91	.094	1.36	.026	28.00
	2[b]	18	3.11	1.600	51.43	.139	8.68
	Average		5.01	0.847	26.40	.825	18.34
Finely ground 5% grit	1[a]	13	13.46	8.770	65.14	7.38	84.15
	2[b]	23	11.63	10.870	93.47	9.52	87.58
	Average		12.55	9.820	79.30	8.45	85.86
Coarse feed no grit	1[a]	38	6.90	0.290	4.20	0.170	59.00
	2[b]	18	4.33	2.320	53.60	1.140	49.14
	Average		5.62	1.305	28.90	0.655	54.07
Coarse feed 5% grit	1[a]	21	15.00	8.952	59.68	7.524	84.05
	2[b]	23	12.00	10.780	89.83	9.391	87.12
	Average		13.50	9.866	74.75	8.458	85.59

a - At end of 20 weeks. S.C. White Leghorn pullets started as day-old chicks in batteries and continued in batteries to end of experiment.

b - Pullets from Exp. 1 after 38 weeks of egg production in laying batteries.

c - After birds were fasted for 24 hours.

Table 8

Weight of gizzards and amount of adhering fat as affected by coarse and finely ground feed with and without granite grit

Ration	No. gizzards	Av. weight per: Gizzard	Av. weight per: Gizzard lining	Average weight adhering to each gizzard	Percent weight of adhering fat to gizzard weight
		(gm)	(gm)	(gm)	(Pct)
Finely ground without grit	10[c]	30.1	1.80	7.3	24.0
Finely ground with grit[a]	11[c]	38.4	2.00	4.0	10.0
Coarse feed without grit	10[c]	35.5	2.00	1.3	3.5
Coarse feed with grit[a]	11[c]	40.4	2.33	4.3	10.6
Coarse feed with grit[b]	11[d]	37.2	2.14	2.8	7.5

a - Medium sized five percent mixed with feed

b - Free choice and from range

c - From battery raised pullets at age of 20 weeks

d - From range raised pullets at age of 20 weeks

Table 9

Coarse feed[a] mixtures for layers

Ingredients	No. 1	No. 2
Whole corn	20	-
Whole oats	20	20
Ground corn-coarse	15	35
Wheat middlings	15	10
Wheat bran	10	10
Alfalfa meal[b]	5	5
Soybean oil meal	7	10
Meat scraps[c]	30	4
Dried whey	25	2.5
Fish meal-menhaden	2.0	2.0
Bone meal-steamed	-	1.0
Salt-manganese mix[d]	0.5	0.5
Feeding oil[e]	0.25	0.25

a - Finely ground feed prepared by grinding coarse feed

b - Dehydrated 17% protein

c - Meat and bone meal - 50% protein

d - Composed of iodized salt 9, Tech. manganese sulfate 1.

e - 1500 A, 400 D

Table 10

Egg production and feed utilization as affected by coarse feed with and without the free choice of oyster shell or insoluble grit[a]

Ration[b] with free choice of:	Eggs per bird	Feed per dozen eggs	Percent intake of[c]	
			Oyster shell	Insoluble grit
Oyster shell	143	8.24	5.06	-
Granite grit	81[d]	13.72	-	25.90
Oyster shell Granite grit	150	7.75	5.07	0.55
Oyster shell Silica grit	155	7.63	5.04	0.32

a - Experiment conducted with four groups each of 50 (total of 200) Rhode Island Red pullets during 46 weeks.

b - No. 1 (see table 9)

c - Of total feed

d - This is the number of eggs that could be recorded. Many were not recorded because of weak or soft shells and egg eating.

Table 11

Intake of granite grit by layers as affected by free choice of calcite grit vs. five percent pulverized calcite mixed with feed[a]

Exp. No.	No. birds	Free choice calcite grit				Five percent pulverized calcite mixed with feed			
		Eggs per bird	Feed per doz. eggs.	Percent calcite grit[b]	Percent granite grit[b]	eggs per bird	Feed per doz. eggs	Percent calcite (pulv.)[b]	Percent granite grit[b]
			(lb)	(pct)	(pct)		(lb)	(pct)	(pct)
1	90	187	5.10	5.73	0.59	185	4.92	5.00	9.05
2	100	153	6.26	4.25	1.23	138	6.72	5.00	8.40
Average		170	5.68	5.04	0.91	161	5.82	5.00	8.72

a - Coarsely ground No. 1

b - Of total feed

Table 12

Egg production and feed utilization as affected by limestone grit with and without insoluble grit

Exp. No.	No. birds	Eggs per bird		Feed per dozen eggs		Percent calcium supplement[a]		Percent[a] Insoluble grit
		With insoluble grit	No insoluble grit	With insoluble grit	No insoluble grit	With insoluble grit	No insoluble grit	
				(lb)	(lb)	(pct)	(pct)	(pct)
Coarse feed[a] and calcite grit[b] with and without granite grit[c]								
1	90	187	168	5.10	5.42	5.73	6.18	0.59
2	90	153	146	6.26	6.03	4.25	3.69	1.23
3	120	179	153	7.01	7.94	4.09	4.26	2.20
Average		173	156	6.12	6.46	4.69	4.71	1.27
Finely ground feed[a] and calcite grit[c] with and without granite grit[b]								
4	90	173	167	5.70	5.60	5.59	6.30	0.12
5	90	157	156	5.97	6.20	5.06	4.38	0.83
Average		165	162	5.84	5.90	5.23	5.34	0.48

a - Ration No. 1

b - Of total feed

c - Free choice

Note - Experiments 1 and 2 are comparable with 4 and 5

Table 13

Egg production and feed utilization as affected by the ration[a] with free choice of granite vs. silica grit

Exp. No.	No. birds	Eggs per bird			Feed per dozen eggs			Grit intake	
		No grit	Granite grit	Silica grit	No grit	Granite grit	Silica grit	Granite	Silica
					(lb)	(lb)	(lb)	(pct)	(pct)
1	150	143[1]	150	155	8.23	7.80	7.60	0.55	0.32
2	135	141[1]	138	154	6.62	6.72	6.17	1.72	0.37
3	150	159[2]	162	178	6.87	6.59	5.89	1.01	0.22
4	150	132[2]	152	160	8.59	7.63	7.49	1.70	0.28
Average		144	151	162	7.58	7.19	6.79	1.29	0.30

a - Coarse feed (No. 1 Exps. 1 and 2, No. 2 Exps. 3 and 4) and free choice of oyster shell

b - Percent of total feed intake

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